April 17, 1951 J. A. FAVRE 2,549,441

ELECTRIC SWITCH OPERATOR

Filed Sept. 23, 1947 2 Sheets-Sheet 1

Fig. 1.

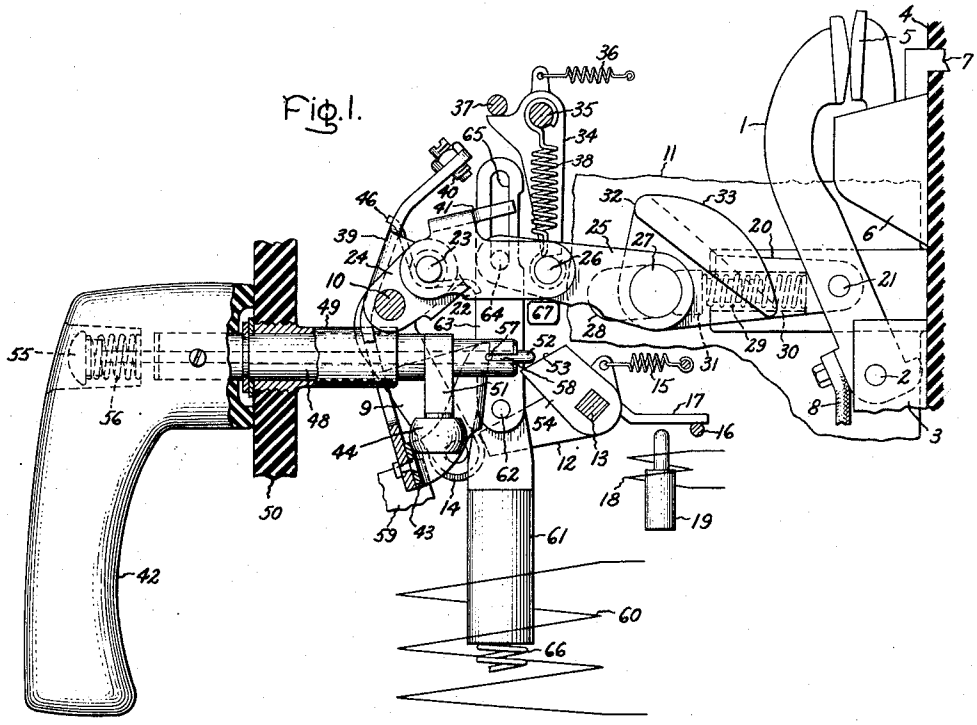


Fig. 2.

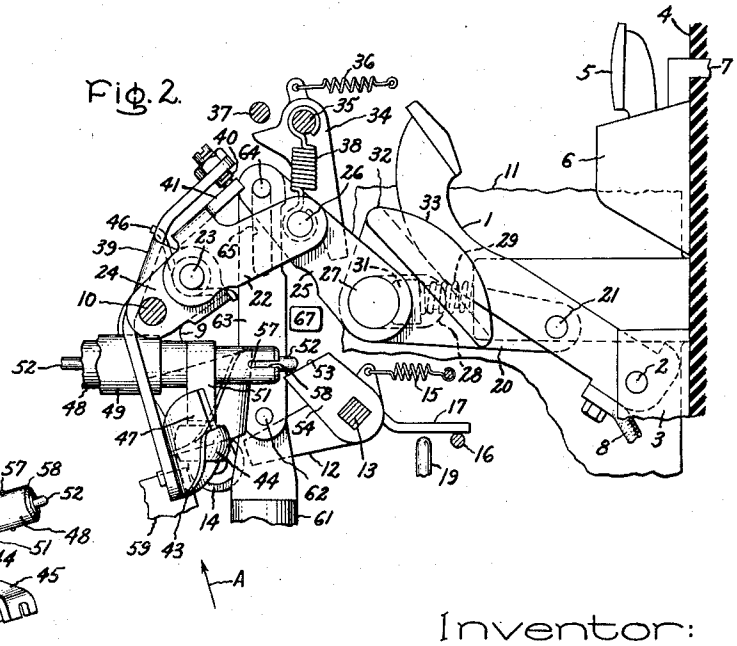
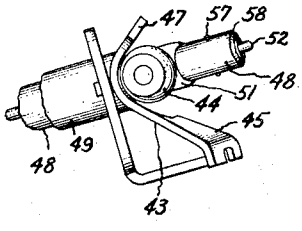


Fig. 3.



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Fig. 4.

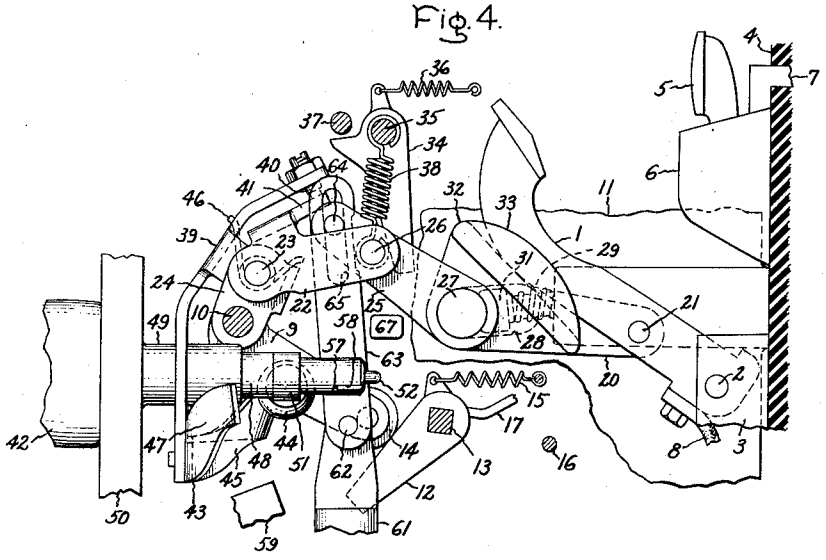
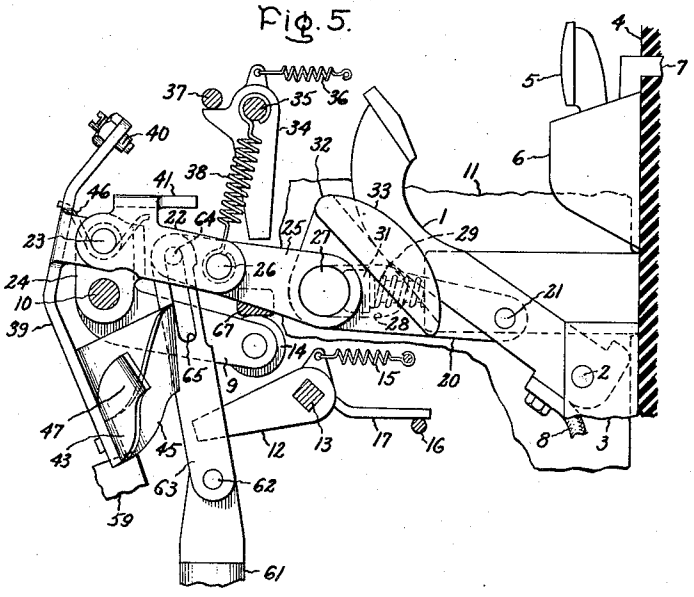


Fig. 5.



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ELECTRIC SWITCH OPERATOR

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Application September 23, 1947, Serial No. 775,573

10 Claims. (Cl. 200—89)

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My invention relates to improvements in electric switches and more particularly to improvements in electric circuit breakers, and especially automatic trip-free circuit breakers which may be operated to the closed circuit position by a manually rotatable handle and also by electromagnetic means.

An object of my invention is to provide an improved automatic trip-free circuit breaker which for given interrupting and continuous ratings has a very compact overlapping structure in order to meet limited space requirements. Another object of my invention is to provide an improved circuit breaker toggle operating mechanism which is closable by a rotatably mounted operating handle having an axis offset perpendicularly to and adjacent a pivot of the toggle and also by electromagnetic means operating adjacent the toggle pivot and transverse the axis of the handle. Still another object of my invention is to provide an improved automatic trip-free circuit breaker structure wherein the latching mechanism is automatically reset and wherein the operating handle automatically returns to a given position when released after closing or trying to close the circuit breaker. A further object of my invention is to provide an improved circuit breaker toggle operating mechanism with an improved form of rotatable handle right angular cam rotation transmitting reset mechanism. These and other objects of my invention will appear in more detail hereinafter.

My invention will be better understood from the following description when considered in connection with the accompanying two sheets of drawings, and its scope will be pointed out in the appended claims.

In the accompanying two sheets of drawings, Fig. 1 is a side elevation, partly in section, of an automatic trip-free circuit breaker embodying my invention and shown in the latched closed position; Fig. 2 is a view similar to Fig. 1 showing the circuit breaker open with the mechanism in the reset position; Fig. 3 is a partial view of a cam and roller closing mechanism embodying my invention and looking in the direction indicated by the arrow A in Fig. 2; Fig. 4 is a side elevation of the circuit breaker shown in Fig. 1 with the parts in position following automatic tripping while holding the operating handle in the closed position; and Fig. 5 is a side elevation similar to Fig. 4 but showing the parts in position following automatic tripping while the electromagnetic closing means remains energized.

In the illustrated embodiment of my invention, I have shown an automatic trip-free circuit breaker comprising a movable circuit controlling member 1 pivotally mounted at 2 on a support 3 secured to a suitable base 4, which may be of molded insulation or the like, for movement

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into engagement with a stationary contact 5 also mounted on the base 4 and shielded by an insulator cap 6. The stationary contact 5 is conductively related to an upper stud 7, and at its pivoted end the circuit controlling member is shown as provided with a flexible lead 8.

For moving the circuit controlling member 1 to and holding it in the closed position shown in Fig. 1, I provide actuating means comprising a movable tripping element such as a bell crank 9 which is pivotally supported on a pin 10 mounted in side frames 11, which in a three-pole circuit breaker are positioned between the intermediate and outside poles. For holding the crank 9 against movement in one direction, counterclockwise as viewed in Fig. 1, I provide releasable means such as a latch 12 which is carried on a trip shaft 13 and which engages with a roller 14 pivotally supported at the free end of the lower arm of the crank 9. The trip shaft 13 is biased for clockwise movement to the holding position by suitable means such as a spring 15, the movement being limited by a stop 16 against which a tripping arm 17 on the shaft abuts. For releasing the latch 12 to permit counterclockwise movement of the crank 9 and thereby to effect the opening of the circuit breaker, as will more clearly appear hereinafter, I provide suitable tripping means shown as an energizing winding 18 and a cooperating plunger armature 19 positioned for movement into engagement with the tripping arm 17 upon suitable energization of the winding 18. The winding or trip coil 18 may be energized in any suitable manner to respond to abnormal conditions of the circuit through the circuit breaker and otherwise, as is well known to the art.

For holding the circuit controlling member 1 in the closed position when the latch 12 is in engagement with the roller 14 on the crank 9 and also for actuating the circuit controlling member 1 to the closed position, I provide a linkage interconnecting the crank 9 and the circuit controlling member. As shown, this comprises a first link 20 pivotally connected to the circuit controlling member 1 at 21, a second link 22 pivotally connected at 23 to the upper arm 24 of the crank 9, and an intermediate link 25 pivotally connected to the links 20 and 24 at 26 and 27, respectively. In accordance with my invention, I provide guiding means for causing a remote point of the link 20 to move within predetermined limits in a predetermined path. As shown, this is accomplished by having the pivotal connection 27 between the link 20 and the link 25 arranged for movement along guideways 28 provided in the side frames 11. The pivot 27 extends across all poles of the circuit breaker so as to interconnect the links 20 for simultaneous movement.

For effecting movement of the pivotal shaft 27 when the linkage is released whereby to effect the opening of the circuit breaker, I provide means opposing movement of the shaft from left to right, as viewed in Fig. 1, and operative to effect movement thereof in the opposite direction when the linkage mechanism is released upon a tripping actuation of the circuit breaker trip shaft 13. As shown, this means comprises a compression spring 29 which is housed in a suitable opening in a portion 30 of the side frame 11. Between the outer end of the spring 29 and the shaft 27 is a shoe 31 against which the spring presses to tend to effect the circuit opening movement of the circuit controlling member 1 when the linkage mechanism is released. For a three-pole circuit breaker, two springs 29 are preferably provided respectively mounted in pockets in the side frames 11 between the intermediate pole and the outside poles. For shock-absorbing purposes upon the opening movement of the circuit controlling member 1, the insulating link 20 may be provided with a buffer portion 32 against which the circuit controlling member strikes. If the circuit controlling member 1 consists of a plurality of simultaneously movable parallel conducting members, then the buffer portion 32 may be provided with one or more spaced walls or anti-creepage barriers 33 between which the parallel portions of the circuit controlling member are pocketed upon the circuit opening movement.

It will be noted that the links 22 and 25 constitute a holding toggle which, when moved into the underset position shown in Fig. 1, is arranged to be held in this position by a prop latch 34 which is pivotally supported at 35 and which is biased for clockwise movement by suitable biasing means such as a spring 36 tending to move the prop latch to the holding position. Clockwise movement of the prop latch 34 is limited by a stop 37. It will be noted that when the trip latch 12 is turned counterclockwise, the compression in the opening spring 29 tends to force the link 25 from right to left thereby causing the pivot pin 26 to move to the left away from the lower end of the prop latch 34 whereupon suitable biasing means such as a spring 38 secured between the toggle knee pivot 26 and the stationary pivot 35 accelerates the collapse of the toggle 22—25. This collapsed condition is clearly shown in Fig. 2.

For actuating the operating toggle 22—25 to the underset position where it may be held by the holding means or prop latch 34 as long as the trip latch 12 engages the roller 14, I provide actuating means which, as shown, comprises a cam carrying operator 39 pivotally supported for rotation about the pivotal junction 23 of the crank 9 and the toggle link 22 with all the pivot axes parallel. The operator 39 closely overlaps the bell crank 9 and carries adjacent one end thereof an adjustably positioned projection 40 which upon clockwise movement of the operator about its pivot 23 engages a transverse bridging portion 41 extending between the side portions of the toggle link 22. This engagement is shown in Figs. 2 and 4.

For effecting the clockwise rotation of the operator 39 whereby to close the circuit breaker by a manually operable rotatably mounted member 42 which has its axis of rotation offset perpendicularly to and adjacent the axis 23 of rotation of the operator 39 so as to extend transverse the lower side of the operator 39, I provide on

the lower end of the operator 39 a specially shaped cam 43. This cam has an extended wing 45 of substantially helicoid form so as to be engaged by a cam follower 44 which is mounted for clockwise rotation with the operating handle 42 to produce a clockwise rotation of the operator 39 with the respective axes of the rotating handle and the rotating operator offset perpendicularly adjacent each other. Thus, the cam 43 and cam follower 44 form a compactly nesting right angular rotation transmitting mechanism between the rotatable handle 42 and the operator 39. As shown more clearly in Fig. 3, the cam 43 is a double winged centering cam to provide a centering operation of the operating handle 42 when it is released following closure of the breaker or an attempt to close it on a faulty condition. Thus, as shown more clearly in Fig. 3, the cam 43 comprises an operating wing 45 which is engaged by the follower 44 when the handle 42 is turned clockwise as viewed from the front of the circuit breaker to ride along the wing portion 45 and thereby to effect clockwise rotation of the operator 39 and straightening of the operating toggle 22—25 to close the circuit breaker. For turning the operating handle 42 to the neutral or off position when released, I provide suitable means such as a torsion spring 46 which surrounds the pivot pin 23 and engages the upper arm 24 of the crank 9 and the operator 39 to tend to move the lower end of the operator 39 toward the lower end of the crank 9. During this movement, the follower 44 is forced to ride along the cam surface 45 until the lower position or valley of the cam is reached thereby centering the operating handle 42 in the neutral or off position shown in Fig. 1. The other wing 47 of the cam prevents overtravel of the operating handle when it is released.

As shown, the operating handle 42 is secured to a shaft 48 mounted in a bushing 49 which is supported in the circuit breaker escutcheon 50, shown as insulating material. The cam follower 44 is also secured to the shaft 48 for movement with the handle 42 and, as shown, is rotatably mounted on a crank arm 51 depending from the handle mounting shaft 48 that extends transverse the lower side of operator 39 so as to rotate the arm 51 in the open space between the pivot 23 and cam 43 as shown in Figs. 1 and 2. For manually tripping the circuit breaker, the shaft 48 may be hollow, as shown, and provided with a trip rod 52 longitudinally slidable therein for engagement with an inclined edge 53 of a tripping arm 54 secured to the trip shaft 13, as shown more clearly in Figs. 1 and 2. For actuating the trip rod 52 in a direction to cause counterclockwise movement of the trip shaft 13 and release the trip latch 12, the trip rod 52 is moved inwardly by pressing on a plunger button 55 against the bias of a spring 56 mounted in a hole in the operating handle 42. Upon release of the plunger 55, the spring 56 returns the trip rod 52 to the position shown in Fig. 1, the longitudinal movement from right to left being limited by a projection 57 on the trip rod coming against the end of a slot 58 in the operating shaft 48.

Inasmuch as the torsion return spring 46 tends to turn the crank 9 clockwise, the motion of this crank in this direction is limited by a stop 59, as shown in Fig. 2. During energy releasing movement of the torsion spring 46 when the lower ends of the operator 39 and the crank 9 are moved toward each other, there is sufficient clear-

ance between the roller 14 on the lower end of the crank 9 and the trip latch 12 to permit the resetting of this latch under the bias of the spring 15 during the opening movement of the circuit breaker so that when the operating handle 42 is turned clockwise, viewed from the front of the circuit breaker, the circuit breaker can be closed. It is, therefore, unnecessary to have an auxiliary movement of the operating handle in one direction or the other to reset the circuit breaker mechanism before the circuit breaker can be reclosed.

For closing the circuit breaker by power actuated means, I provide electromagnetic means comprising a winding 60 and a plunger armature 61, which is pivotally secured at 62 to a link 63 which is connected for lost motion to the toggle link 25 at a point thereof such in conjunction with the movement of the toggle knee or junction 26 and the relative lengths of the links 20, 22 and 25 that the downward pull of the plunger 61 when the winding 60 is energized is exerted substantially in line with the travel of the plunger 61. Thus, for example, near the extended overlapping end of the toggle link 25 and between the toggle pins 23 and 26, the toggle link 25 is provided with a pin 64 which travels in a slot 65 provided in the link 63. The length of this slot 65 is such that the opening movement or collapse of the linkage mechanism is not in any way restrained by the weight of the plunger 61 and the parts attached thereto. For biasing the plunger 61 to the unattracted position against the effect of gravity, suitable means such as a compression spring 66 is provided. For preventing overtravel of the bell crank 9 when the circuit breaker is operated by the electromagnetic means 60, 61, I provide a stop 67 against which the roller 14 on the lower arm of the bell crank 9 comes to rest when the circuit breaker is electrically closed on a fault and tripped, as shown more clearly in Fig. 5.

Assuming the circuit breaker closed with the parts positioned as shown in Fig. 1, then if the trip shaft 13 is turned counterclockwise either by actuation of the trip rod 52 or the tripping plunger 19, the latch 12 is turned from its restraining position to release the roller 14 at the lower end of the bell crank 9. Under the bias of the opening spring 29, the linkage mechanism 20—22—25 moves from right to left thereby causing the knee pin 26 of the operating toggle 22—25 also to move to the left away from the prop latch 34, whereupon the spring 38 accelerates the collapse of the operating toggle and the circuit controlling member 1 moves to the open position, as shown in Fig. 2. During this opening movement, the torsion spring 46 also causes the bell crank 9 to turn clockwise with its motion limited by the stop 59, whereupon the latch resetting spring 15 turns the trip latch 12 to the reset position shown in Fig. 2.

To close the circuit breaker, the operating handle 42 is turned clockwise as viewed from the front of the circuit breaker. During this movement, the cam follower 44 on the operating handle shaft 43 is caused to move up the inclined face 45 of the cam 43, whereupon the toggle 22—25 is moved to its underset position with the circuit controlling member 1 in the closed position. During this movement, the opening spring 29 is stressed, and the prop latch resetting spring 36 restores the prop latch 34 to the toggle holding position.

If the circuit breaker is closed on an abnormal circuit condition, then the trip latch 12 is immediately actuated to trip the circuit breaker. Assuming that the operator has held onto the handle 42, then the parts are positioned as shown in Fig. 4 since the cam follower 44 is held on the high side of the wing portion 45 of the cam 43. Upon release of the handle 42, however, the stressed torsion spring 46 moves the cam 43 counterclockwise, as viewed in the drawings, to center the cam follower 44 and thereby the operating handle 42 in the neutral or off position. During this counterclockwise movement of the operator 39, the bell crank 9 and the trip latch 12 are restored to the relative positions they occupy in Fig. 2, and the circuit breaker mechanism is reset ready for closing.

As shown in Fig. 2, the pin 64 is at the top of the slot 65 in the link 63 which is connected to the plunger 61. If the winding 60 associated with this plunger is energized, then the pin 64 on the operating toggle link 25 is caused to move downwardly whereby to set the toggle 22—25 in the underset position where it is retained by the prop latch 34. In this case, the parts are again in position as shown in Fig. 1 except that the plunger 61 is drawn into its energizing winding 60. If the reclosing operation occurs while an abnormal condition prevails on the circuit through the circuit breaker, then the trip latch 12 will immediately be released. Thereupon, the linkage mechanism is free to move from right to left and the parts are positioned as shown in Fig. 5. During this movement, the operating toggle 22—25 is maintained substantially in a straight line position by the pull of the plunger 61. Consequently, the bell crank 9 is caused to have a greater counterclockwise movement than when the circuit breaker is tripped during manual operation because the pin 23 is moved farther to the left. In this case, the roller 14 on the bell crank 9 moves to the position shown in Fig. 5 against the stop 67. When the winding 60 is deenergized, the plunger 61 moves upwardly under the bias of its lifting spring 66 and the toggle 22—25 is collapsed by the spring 38, whereupon the parts are restored to the reset position shown in Fig. 2.

While I have shown and described my invention in considerable detail, I do not desire to be limited to the exact arrangement shown, but seek to cover in the appended claims all those modifications that fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric switch comprising a rotatable circuit controlling member, a rotatable bell crank having releasable latching means engaging one arm thereof, an operator pivotally supported on the other arm of said bell crank for separate rotation about an axis parallel with both the axis of the crank and the axis of the member, a linkage connection between said crank and said member comprising a toggle having one of its links connected to the crank at the junction of said operator and the crank and the other of its links connected to said member, a wing cam mounted on said operator to extend laterally on one side of its pivotal support and the operator having an extension on the other side of its pivotal support engageable with said toggle for moving the toggle to actuate the member to the closed position, an operating handle having a rotatable shaft operated thereby and mounted for rotation about an axis offset perpendicularly to the axis of rotation

of said operator and means including a cam follower rotatable with said shaft and engageable with said cam upon rotation of the handle in one direction to form a right angular rotation transmitting mechanism for effecting the rotation of said operator into engagement with said toggle.

2. An electric switch comprising a rotatable circuit controlling member, a rotatable bell crank having releasable latching means engaging one arm thereof, an operator pivotally supported on the other arm of said bell crank for separate rotation about an axis parallel with both the axis of the crank and the axis of the member, a linkage connection between said crank and said member comprising a toggle having one of its links connected to the crank at the junction of said operator and the crank and the other of its links connected to said member, a centering double wing cam mounted on said operator to extend laterally on one side of its pivotal support and the operator having an extension on the other side of its pivotal support engageable with said toggle for moving the toggle to actuate the member to the closed position, an operating handle having a rotatable shaft operated thereby and mounted for rotation about an axis offset perpendicularly to the axis of rotation of said operator, means including a cam follower rotatable with said shaft and engageable with said cam upon rotation of the handle in one direction to form a right angular rotation transmitting mechanism for effecting the rotation of said operator into engagement with said toggle, and resilient means for effecting the reverse rotation of said operator upon release of the handle whereby to return the handle to a predetermined initial position.

3. An electric switch comprising a rotatable circuit controlling member, a rotatable bell crank having releasable latching means engaging one arm thereof, an operator pivotally supported on the other arm of said bell crank, a linkage connection between said crank and said member comprising a toggle having one of its links connected to the crank at the junction of said operator and the crank and the other of its links connected to said member, a centering cam mounted on said operator on one side of its pivotal support and the operator having an extension on the other side of its pivotal support engageable with said toggle for moving the toggle to actuate the member to the closed position, means for actuating said operator to effect said toggle movement comprising an operating handle mounted for rotation about an axis offset perpendicularly to the axis of rotation of said operator, means including a cam follower movable with said handle and engageable with said cam upon rotation of the handle in one direction to form a right angular rotation transmitting mechanism for effecting the rotation of said operator into engagement with said toggle, and a torsion spring around the pivotal junction of said crank and said operator having extensions respectively engageable with the operator and the crank and adapted to be stressed during the switch closing movement of the operating handle whereby upon release of the handle to effect reverse rotation of the operator to move the handle to the off position.

4. An electric switch comprising a movable circuit controlling member, a movable tripping element having a trip latch engaging therewith, a linkage connection between said member and said element comprising an operating toggle having two interconnected links, one of said links being pivoted on the element and the other link being connected to the member, a centering cam having a lever arm mounted for pivotal movement about the junction of said element and said one toggle link, an operating member rotatable about an axis offset perpendicularly to the axis of movement of said cam, a cam follower mounted for movement with and in the same direction as said operating member to form a right angular rotation transmitting mechanism with said cam for moving said lever arm into engagement with said other toggle link upon movement of the operating member in one direction to effect movement of said toggle to an underset position and said circuit controlling member to the circuit closed position, a prop latch movable into engagement with said toggle for maintaining the underset position thereof as long as said trip latch engages said element, and biasing means tending to move said cam into engagement with said follower whereby to return said operating member to an initial position following release thereof after movement of the circuit controlling member to the circuit closed position.

5. An electric switch comprising a pivotally supported circuit controlling member, a pivotally supported tripping element, a trip latch engageable with said element to prevent rotation thereof in one direction, a linkage comprising a first link connected to said member, a second link connected to said element, and an intermediate link interconnecting said first and second links, said intermediate and second links forming an operating toggle, a guideway supporting the junction of said first and intermediate links for substantially rectilinear movement, biasing means opposing movement of said junction in the circuit closing direction, a double winged cam having a lever arm overlapping said second link and mounted for rotation about the junction of said element and said second link, an operating member rotatable about an axis offset perpendicularly to the axis of rotation of said cam, a cam follower positioned between the wings of said cam and mounted for rotation with and in the same direction as said operating member to engage said lever arm with said second link upon rotation of the operating member in one direction to effect movement of said toggle to an underset position and said circuit controlling member to the circuit closed position, a prop latch movable into engagement with said toggle for maintaining the underset position thereof as long as said trip latch engages said element, and biasing means tending to move said cam into engagement with said follower whereby to return said operating member to an initial position following release thereof after movement of the circuit controlling member to the circuit closed position.

6. An electric switch comprising a movable circuit controlling member, a movable tripping element, holding means engageable with said element for preventing movement thereof in one direction, a first link pivotally connected to said member, a second link pivotally connected to said element, an intermediate link pivotally interconnecting said first and second links and forming with said second link an operating toggle with an end of one of the toggle links overlapping the other link, means supporting the junction of said first and intermediate links for a predetermined movement, resilient means opposing movement of said member to one circuit controlling position, actuating means connected to the overlapping end of said one toggle link for effecting rectilinear movement of said member to one cir-

cuit controlling position when said holding means engages said element, the point of connection of said actuating means to said one toggle link, the movement of said junction and the relative lengths of said links being such that during the movement of said member to said circuit controlling position the movement of said connection point is substantially rectilinear, and holding means movable into engagement with said toggle upon movement of said member to the one circuit controlling position for maintaining the member in said circuit controlling position as long as said holding means engages said tripping element.

7. An electric switch comprising a movable circuit controlling member, a movable tripping element, a trip latch engageable with said element to prevent movement thereof in one direction, a linkage comprising a first link pivotally connected to said member, a second link pivotally connected to said element, and an intermediate link pivotally interconnecting said first and second links, said intermediate and second links forming an operating toggle with one end of the intermediate link overlapping the second link, a guideway supporting the junction of said first and intermediate links for a predetermined rectilinear movement, biasing means opposing movement of said member to the circuit closing position, actuating means connected to the overlapping end of said intermediate toggle link for effecting movement of said member to the circuit closing position when said trip latch is in engagement with said element, the point of connection of said actuating means to said intermediate toggle link, the movement of said junction and the relative lengths of said links being such that during the switch closing movement of said member the movement of said connection point is substantially rectilinear, and a prop latch movable into engagement with said toggle in an underset position thereof upon movement of said member to said circuit closing position whereby to maintain the member in such position as long as said trip latch engages said tripping element.

8. An electric switch comprising a pivotally supported circuit controlling member, a pivotally supported tripping element, a trip latch engageable with said element to prevent rotation thereof in one direction, a linkage comprising a first link pivotally connected to said member, a second link pivotally connected to said element, and an intermediate link pivotally interconnecting said first and second links, said intermediate and second links forming an operating toggle with one end of the intermediate link overlapping the second link, a guideway supporting the junction of said first and intermediate links for substantially rectilinear movement, biasing means opposing movement of said member to the circuit closed position, actuating means connected to the overlapping end of said intermediate toggle link for effecting movement of said member to the circuit closed position when said trip latch is in engagement with said element, the point of connection of said actuating means to said intermediate toggle link, the movement of said junction and the relative lengths of said links being such that the movement of said connection point is substantially rectilinear, and a prop latch biased for movement into engagement with said toggle in an underset position thereof upon movement of said member to the circuit closed position whereby to maintain the member in such position as long as said trip latch engages said tripping element.

9. An electric switch comprising a movable circuit controlling member, a rotatably mounted tripping element having an arcuately movable coupling point, releasable means for holding said element against arcuate movement of said coupling point in one direction, a link connected at one point to said member, guide means for causing a remote point of said link to move in a substantially rectilinear path extending substantially in the direction of arcuate movement of said coupling point, a spring opposing movement of said link in the opposite direction, a toggle interconnecting the coupling point of said element and said link, actuating means for straightening said toggle from a buckled position to a given position whereby to move said link against the bias of the spring to effect movement of said member to the switch closed position, and movable stop means engageable with said toggle in said given position to prevent rebuckling of the toggle until longitudinal movement thereof in substantially the direction of arcuate movement of said coupling point, whereby to hold the link against the bias of the spring and the member in the closed position as long as releasable means hold the tripping element against arcuate movement of the coupling point in the said one direction.

10. An electric switch comprising a movable circuit controlling member, a reversely movable tripping element, releasable means for holding said element against movement in one direction, a link connected at one point to said member, guiding means for causing a remote point of said link to move within predetermined limits in a predetermined path extending substantially in said one direction, means including a spring opposing movement of said remote point of said link in the opposite direction and tending to cause movement thereof in said one direction, a toggle interconnecting said element and said link, actuating means for straightening said toggle from a buckled position to a given position in substantial alignment with said link whereby to move the link against the bias of the spring and thereby effect movement of said member to a predetermined circuit controlling position, and movable stop means engageable with said toggle in said given position to prevent rebuckling of the toggle until longitudinal movement thereof in said one position whereby to hold said member in said circuit controlling position as long as said releasable means holds said tripping element against movement in said one direction.

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